

Entiat Spring Chinook Population

The Entiat spring Chinook population is part of the Upper Columbia ESU. This ESU contains only one extant MPG including 3 current populations—Wenatchee, Entiat, and Methow Rivers and one extinct population, the Okanogan (ICTRT 2004). For general descriptions of the subbasins and life history characteristics of these populations see NPPC (2004) or the Upper Columbia Recovery Plan (UCSRB 2006).

The ICTRT classified the Entiat River spring Chinook population as “basic” in size based on historical habitat potential (ICTRT 2005) (Table 1b). This classification requires a minimum abundance threshold of 500 wild spawners with sufficient intrinsic productivity (greater than 3.4 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Entiat spring Chinook population was classified as a “type A” population (based on historic intrinsic potential) because of its simple, linear tributary structure (ICTRT 2005).

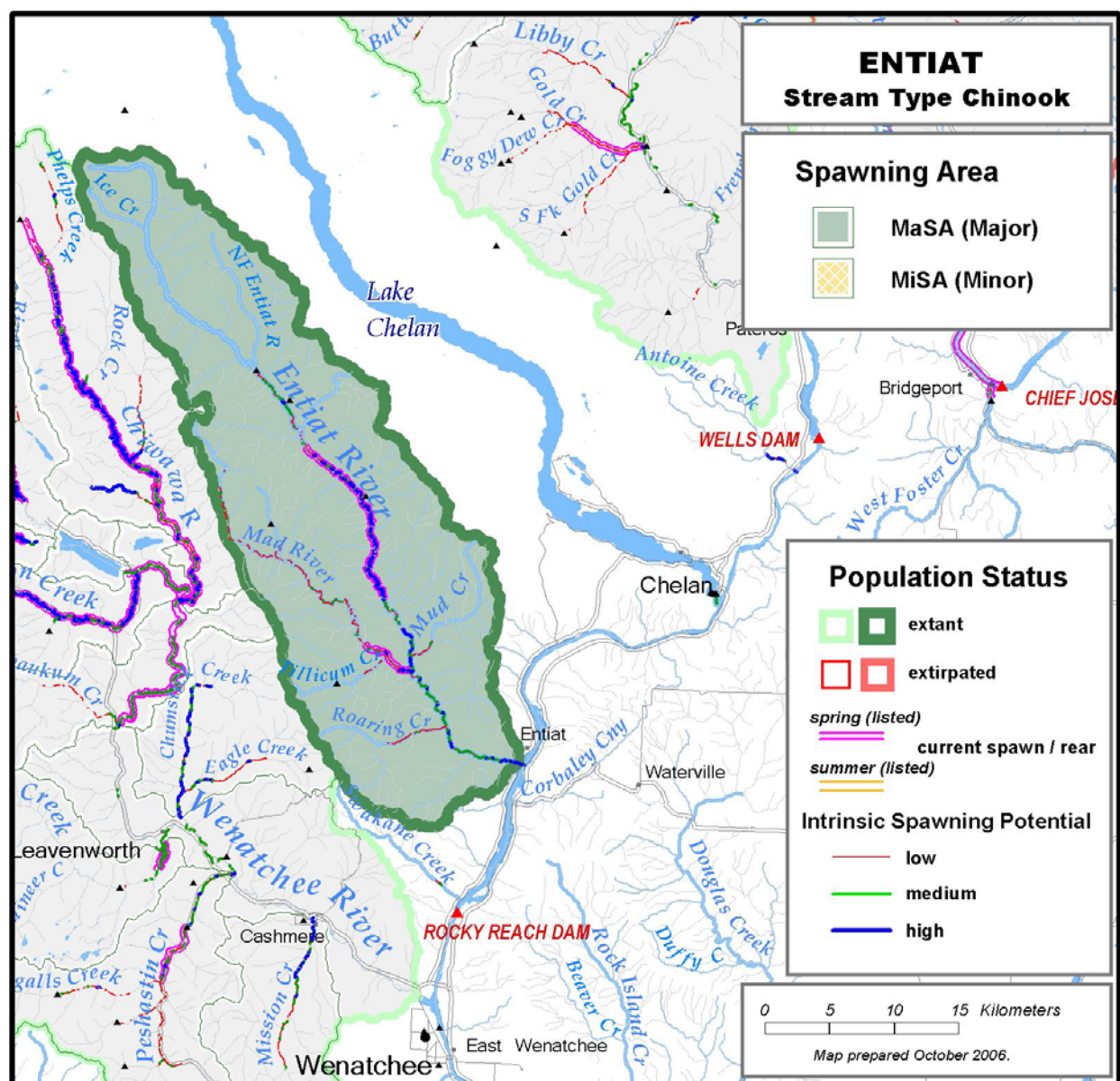


Figure 1. Entiat Spring Chinook population boundaries and major and minor spawning areas.

Table 1. Entiat Spring Chinook basin statistics

Drainage Area (km ²)	1,083
Stream lengths km* (total)	542.7
Stream lengths km* (below natural barriers)	245.4
Branched stream area weighted by intrinsic potential (km ²)	0.422
Branched stream area km ² (weighted and temp. limited)	0.276
Total stream area weighted by intrinsic potential (km ²)	0.537
Total stream area weighted by intrinsic potential (km ²) temp limited	0.377
Size / Complexity category	Basic / A (simple linear)
Number of MaSAs	1
Number of MiSAs	0

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

Current Abundance and Productivity

Current (1960 to 2003) abundance (number of adult spawning in natural production areas) has ranged from 18 (1995) to 1,197 (1964). Abundance estimates are based on expanded redd counts (relatively complete coverage, temporal and spatial components).

Recent year natural spawners include returns originating from naturally spawning parents, and from the Entiat National Fish Hatchery (since 1974). Spawners originating from naturally spawning parents have comprised an average of 58% over the recent (5-year) brood cycle. The most recent 10 year average contribution of naturally produced returns on the spawning grounds has been 69% (Table 2), ranging from 39% to 95%.

Abundance in recent years has been highly variable; the most recent 10-year geomean number of natural spawners was 63 (95 for total spawners). During the period 1960-1999, returns per spawner for spring chinook in the Entiat subbasin ranged from 0.16 to 4.72. The most recent 20-year (1987-1998) geometric mean of returns per spawner (SAR adjusted and delimited at 75% of the threshold) was 0.72 (Table 2).

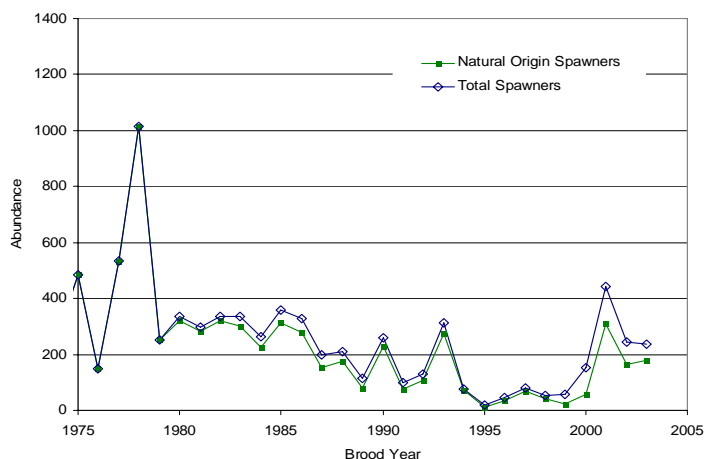


Figure 2. Entiat Spring Chinook abundance from 1960 to 2003.

Table 2. Entiat Spring Chinook abundance and productivity measures

10-year geomean natural abundance	63
20-year return/spawner productivity	0.72
20-year return/spawner productivity, SAR adj. and delimited*	0.72
20-year Bev-Holt fit productivity, SAR adjusted	1.32
Lambda productivity estimate	0.99
Average proportion natural origin spawners (recent 10 years)	69%
Reproductive success adj. for hatchery origin spawners	No data available

*Delimited productivity excludes any spawner/return pair where the spawner number exceeds 75% of the size threshold for this population. This approach attempts to remove density dependence effects that may influence the productivity estimate.

Comparison to Viability Curve

- Abundance: 10-year geomean Natural Origin Returns
- Productivity: 20-year geomean R/S, adjusted for marine survival and delimited at 75% of the threshold.
- Curve: Hockey-Stick curve
- Conclusion: Entiat Spring Chinook population is at **HIGH RISK** based on current abundance and productivity. The point estimate for abundance and productivity is below the 25% risk curve.

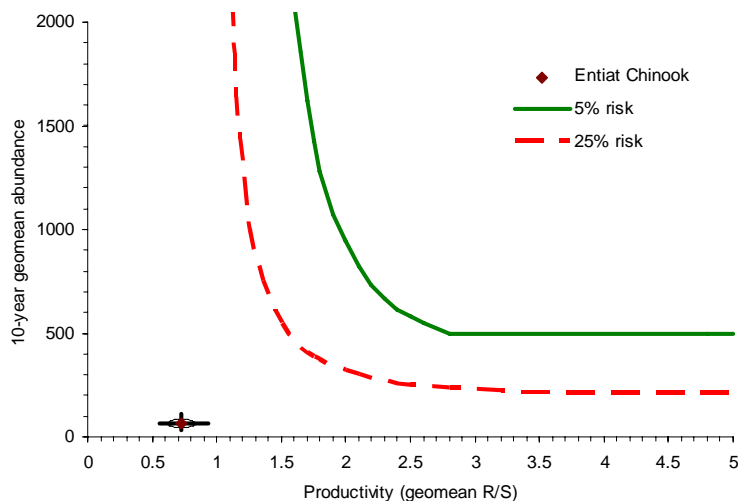


Figure3. Entiat River abundance and productivity metrics against a Hockey-Stick viability curve. Point estimate shown with a 1SE ellipse, 1.81 X SE abundance line, and 1.72 X SE productivity line.

Spatial Structure and Diversity

The ICTRT has identified one historical Major Spawning Area (MaSA)—the Entiat—and no minor spawning areas (MiSAs) within the Entiat population (Figure 5).

Currently, the primary spawning areas used by Spring Chinook in the Entiat population are the mainstem Entiat (above the Mad River), and below Entiat falls (Salmonscape 2003; Hamstreet and Carie 2003; 2004). The Entiat National Fish Hatchery has released unlisted Carson origin spring Chinook into the lower Entiat River annually since 1974. The program is intended to function as a segregated program to augment harvest, the broodstock for this program are not part of the Upper Columbia spring chinook ESU. Spawning ground surveys in 2002 and 2003 substantiate that some Entiat National Fish Hatchery returns stray and spawn in upstream natural production areas (Hamstreet and Carie 2003; 2004).

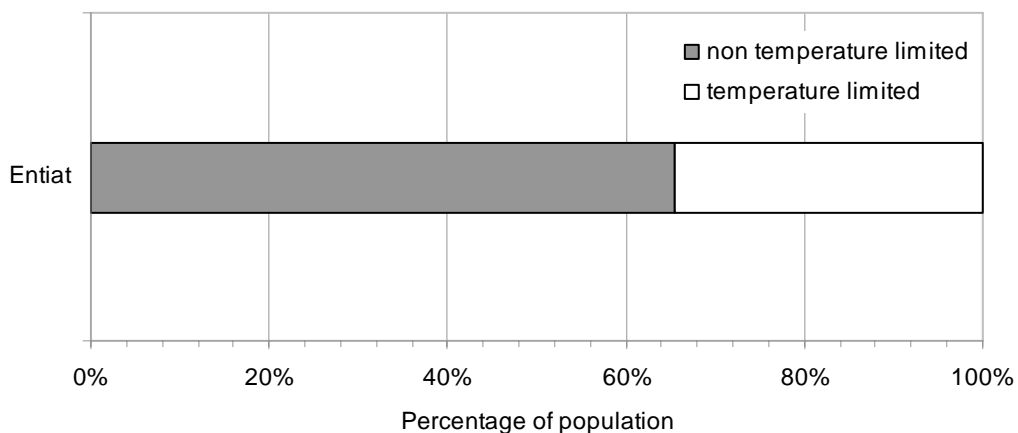


Figure 4. The Entiat River Spring Chinook population has only one MaSA, and no MiSAs. White bars represent current temperature limited areas that could potentially have had historical temperature limitations.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The Entiat Spring Chinook population has one MaSA (Entiat) and it is currently occupied. The single MaSA has been occupied during the previous 5 years (1999-2003) and 14 of the last 15 years (Hamstreet and Carie 2004). The single MaSA had a branched weighted area (0.276 km^2) that was 2.8 times the minimum (0.1 km^2) necessary for a MaSA (Table 1). Therefore, the population was classified as *moderate risk* for this metric, but that risk level is inherent of this small population due to its relatively simple spatial structure. The Mad River is part of the single MaSA, and its capacity is too low to offer any substantial risk moderation.

A.1.b. Spatial extent or range of population.

The single MaSA has been occupied during the previous 5 years (1999-2003) and 14 of the last 15 years (Hamstreet and Carie 2004) so the population is at *low risk* for this metric.

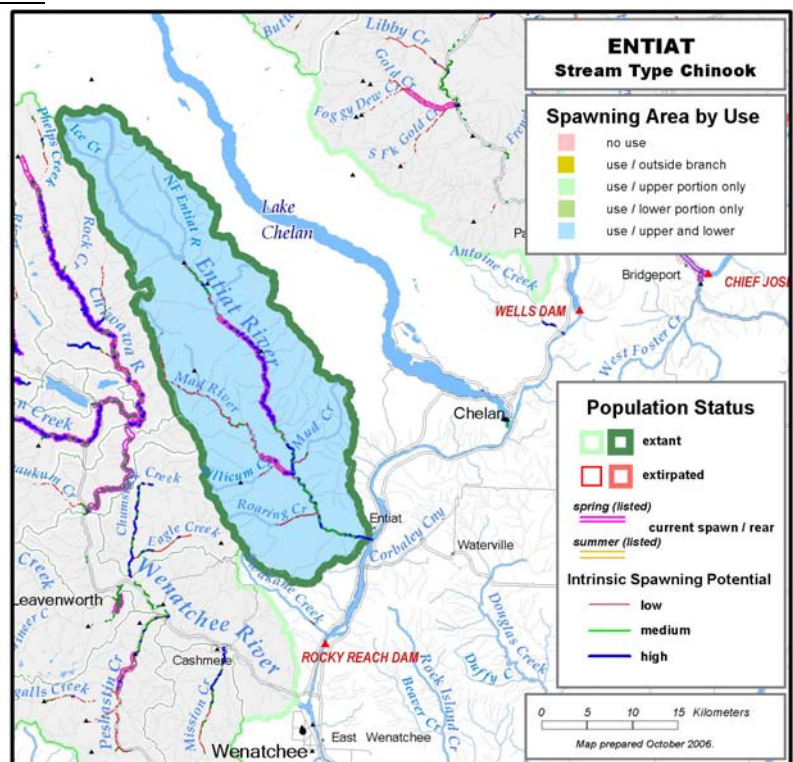


Figure 5. Current spawning distribution of the Entiat Spring Chinook population.

A.1.c. Increase or decrease in gaps or continuities between spawning areas.

The range of spawning distribution has been reduced due to the loss of the lower Entiat mainstem as spring Chinook spawning habitat. In recent years, no spring Chinook spawning has been detected below river mile 13, presumably because of the degraded condition of the habitat due to channelization and the high abundance of Summer/Fall Chinook in the lower Entiat (Hamstreet and Carie 2004). This reduction in range at the lower end of the spawning distribution increases the gap to adjacent populations by more than 10 km but less than 25 km. This situation does not fit precisely within one of the risk level categories in Table 8 of the ICTRT guidance document, but is most consistent with a *moderate risk* rating (ICTRT 2005).

B.1.a. Major life history strategies. The Entiat spring Chinook population is *very low risk*, because no major life history strategies have been lost.

B.1.b. Phenotypic variation. We do not have data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation.

The Entiat spring Chinook population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous and ongoing fish management efforts. Microsatellite samples collected in the late 1990s and early 2000s do not show differentiation, suggesting that recent management practices may have disrupted natural gene flow (IC-TRT pop id draft, in prep). The ICTRT genetic subgroup has reviewed the current status of all populations in the Interior basin. The subgroup concluded that the Entiat population has been homogenized with other UC populations due to past and ongoing hatchery practices. Their conclusion was based on high similarity to all UC hatchery samples and AMOVA analysis indicating no structure. It is possible that the true genetic risk metric for this population is lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; - or genetic information showing strong spatial structure), the risk level for this metric could improve to moderate or low risk.

B.2.a. Spawner composition.

(1) ***Out-of-ESU spawners.*** Out-of-ESU hatchery fish averaged 32% (range 18-53%; 31% from ENFH) of the spawning population from 2000-2004 (USFWS unpublished data). Although 5 years of data may not be adequate to define the risk level with high certainty, the threat remains because the Entiat NFH propagates non-local stock and the broodstock must volunteer to the hatchery while all other spawners are allowed to migrate past the hatchery and spawn with the natural population. Therefore the Entiat spring Chinook population is *high risk* with respect to this metric.

(2) ***Out of MPG spawners.*** The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) ***Out of population spawners.*** Out-of-population, but within ESU (and within MPG) hatchery fish averaged 11% (range 0-25%) of the spawning population from 2000-2004, with 3 of the 5 years less than 10% (USFWS unpublished data). Based on the average spawner composition for one generation the Entiat spring Chinook population is at *moderate risk* with respect to this metric.

(4) ***Within-population strays.*** There is no supplementation program for spring Chinook in the Entiat basin. Therefore, this metric is *not applicable* to the Entiat spring Chinook population.

B.3.a. Distribution of population across habitat types.

The intrinsic potential distribution for Entiat Spring Chinook covered two or three ecoregions, depending on whether a high temperature screen was applied to the historic intrinsic potential distribution (Table 3). If the temperature screen is applied the population is at low risk, if the temperature screen is not applied it is at moderate risk due to the loss of 1 ecoregion (see flow diagram on page 38 of ICTRT 2005). Due to the uncertainty of the historic suitability of the lower Entiat for spring Chinook, and because of the extensive use of the lower Entiat by summer Chinook (a separate ESU), we believe it is most appropriate to use the temperature screen and rate the Entiat population at *low risk* for this metric.

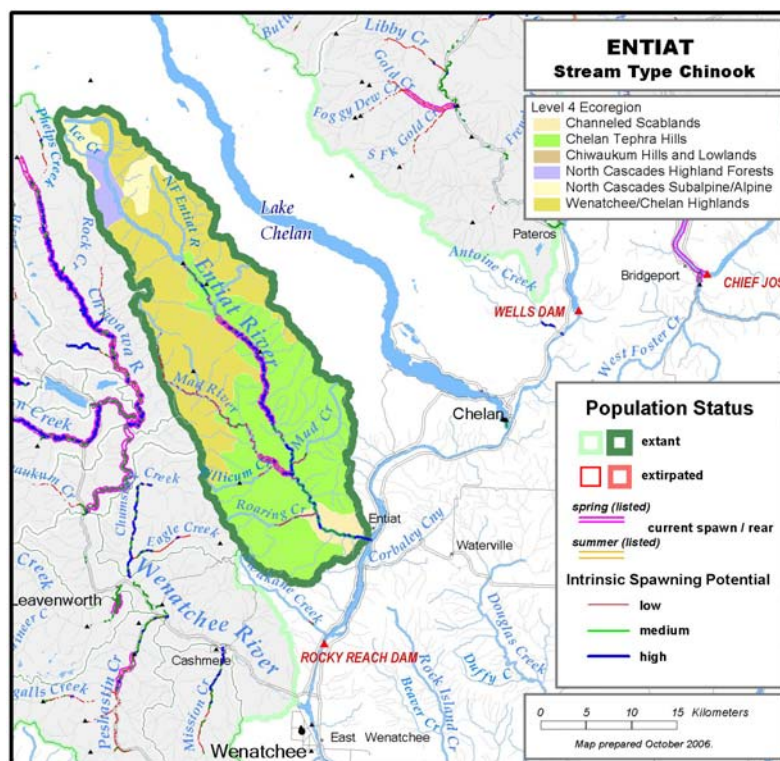


Figure 6. Distribution of the Entiat Spring Chinook population across various ecoregion types.

Table 3. Entiat Spring Chinook – proportion of spawning area across various ecoregions

Ecoregion	% of historical branch spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion	% of historical branch spawning area in this ecoregion (temp. limited)
Channeled Scablands	20.7	0.0	0.0
Chelan Tephra Hills	78.8	99.0	99.1
Wenatchee/Chelan Highlands	0.6	1.0	0.9

*Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: The hydropower system and associated reservoirs impose some selective mortality on smolt out migrants and upstream migrating adults. The hydrosystem has slowed out migration for early and late out migrants; however, in recent years flow augmentation has reduced the impact to the middle 95% of the run. Additional selective pressures of the hydrosystem that warrant further evaluation to rate this metric include size selective predation by piscivores (Baldwin et al. 2003; Fritz and Pearsons 2006) and size-based differential passage mortality through the hydro projects. The magnitude of selective mortality and the proportion of the population that is affected are unknown. The selective mortality is not likely to remove more than 25% of the affected individuals, thus we have rated this metric as *low risk*. However, a

quantitative assessment using empirical data was not conducted, so there was considerable uncertainty in the conclusion that there are not selective pressures acting on the population that warrant a higher risk rating. When additional information is available this component of selectivity should be re-evaluated.

Harvest: *Low risk* in recent generations. Harvest rates effect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Not applicable.

Habitat: *Low risk* no known factors that would be selective.

Based on a low risk rating within all four sectors, the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Entiat spring Chinook population was moderate risk for goal A (allowing natural rates and levels of spatially mediated processes) but high risk for goal B (Maintaining natural levels of variation) resulting in an overall high-risk rating. The metric for genotypic variation (B.1.c) was directly responsible for the high-risk rating and its likely that additional genetic analysis of natural origin Entiat spring Chinook would increase the certainty of this assessment. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting.

There was one metric that was rated at high risk related to spawner composition that did not directly reduce the overall risk conclusion, but should be considered a potential threat to both genotypic (B.1.3) and phenotypic variation (B.1.b). The spawner composition contained a very high proportion of out-of-ESU spawners, primarily from the Entiat National Fish Hatchery. Although reproductive success of ENFH strays is unknown, it is unlikely that genotypic variation consistent with moderate-low risk can be obtained with continued high proportions of these fish on the spawning grounds.

Table 4. Spatial structure and diversity scoring table

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	M (0)	M (0)	Moderate Risk (Mean = 0.33)	Moderate Risk	High Risk
A.1.b	L (1)	L (1)			
A.1.c	M (0)	M (0)			
B.1.a	VL (2)	VL (2)	High Risk (-1)	High Risk	
B.1.b	M (0)	M (0)			
B.1.c	H (-1)	H (-1)			
B.2.a(1)	H (-1)	High Risk (-1)	High Risk (-1)		
B.2.a(2)	NA				
B.2.a(3)	M (0)				
B.2.a(4)	NA				
B.3.a	L (1)	L (1)	L (1)		
B.4.a	L (1)	L (1)	L (1)		

Overall Risk Rating:

The Entiat spring Chinook population is not currently meeting viability criteria. Of particular concern is the high risk rating with respect to abundance and productivity. The population cannot achieve any level of viability without improving its status on the viability curve for both abundance and productivity. Spatial structure and diversity is also currently rated as high risk. Improvement of the spatial structure and diversity status to moderate risk would be required to allow the Entiat population to achieve a “viable” status (in addition to the improvements needed for abundance and productivity). Based on the MPG and ESU guidelines, the Entiat population needs to achieve viable status for its contribution to recovery of the ESU.

		Spatial Structure/Diversity Risk			
		Very Low	Low	Moderate	High
Abundance/ Productivity Risk	Very Low (<1%)	HV	HV	V	M
	Low (1-5%)	V	V	V	M
	Moderate (6 – 25%)	M	M	M	
	High (>25%)				Entiat River

Figure 7. Viable Salmonid Population parameter risk ratings for the Entiat River Spring/Summer Chinook salmon population. This population does not currently meet viability criteria. Viability Key: HV – Highly Viable; V – Viable; M – Maintained; Shaded cells-- not meeting viability criteria (darkest cells are at highest risk)

References

- Baldwin, C. M., J. G. McLellan, M. C. Polacek, and K. Underwood. 2003. Walleye predation on hatchery releases of kokanees and rainbow trout in Lake Roosevelt, Washington. *North American Journal of Fisheries Management* 23: 660-676.
- Fritz, A. L. and T. N. Pearsons. 2006. Effects of predation by nonnative smallmouth bass on native salmonid prey: the role of predator and prey size. *Transactions of the American Fisheries Society* 135:853-860.
- Hamstreet, C. O. and D. G. Carie. 2003. Spring and summer Chinook spawning ground surveys on the Entiat River, 2002. U.S. Fish and Wildlife Service, Leavenworth, Washington.
- Hamstreet, C. O. and D. G. Carie. 2004. Spring and summer Chinook spawning ground surveys on the Entiat River, 2003. U.S. Fish and Wildlife Service, Leavenworth, Washington.
- (ICTRT 2004). Population ID document
- (ICTRT 2005). Viability guideline document
- NPPC 2004. Entiat Subbasin Plan. <http://www.nwcouncil.org/fw/subbasinplanning/entiat/plan>. Portland, Oregon.
- Salmonscape. 2003. Salmonid Fish Distribution - salmonscape.fishdist. Available from Washington Department of Fish and Wildlife. <http://wdfw.wa.gov/mapping/salmonscape/> Olympia, Washington.
- UCSRB. 2006. Draft Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan. Prepared for the Washington State Governors Salmon Recovery Office by the Upper Columbia Salmon Recovery Board. Available online: <http://okanogancounty.org/water/salmon%20recovery;%20draft%20review%20corner.htm>

Entiat Spring Chinook – Data Summary

Data type: Entiat Spring Chinook (without Icicle Creek). Redd count expansions (added wild broodstock)

SAR: Expanded Chiwawa SAR index

Table 5. Entiat Spring Chinook run data (used for Poptools curve fits). All data (1979-1998) were used in the productivity calculation since the parent escapement for every brood year was less than 375 (75% of the size threshold for this population).

Brood Year	Spawners	%Wild	Natural Run	Nat. Rtns	R/S	Rel. SAR	Adj. Rtns	adj R/S
1979	253	1.00	253	277	1.09	1.32	366	1.45
1980	334	0.95	319	208	0.62	0.80	166	0.50
1981	296	0.96	284	344	1.16	0.74	253	0.86
1982	334	0.96	322	249	0.75	0.72	179	0.54
1983	334	0.90	300	226	0.68	0.80	181	0.54
1984	265	0.85	225	55	0.21	1.36	75	0.28
1985	359	0.87	313	184	0.51	1.34	246	0.69
1986	327	0.85	279	146	0.45	1.80	264	0.81
1987	200	0.77	154	86	0.43	1.48	127	0.64
1988	209	0.84	175	232	1.11	0.73	169	0.81
1989	115	0.71	82	153	1.33	1.27	195	1.69
1990	259	0.89	230	41	0.16	3.12	128	0.49
1991	100	0.78	78	22	0.22	7.30	160	1.60
1992	131	0.80	105	44	0.34	5.21	231	1.76
1993	312	0.88	275	58	0.19	0.49	29	0.09
1994	75	0.95	71	38	0.51	1.92	73	0.97
1995	18	0.66	12	34	1.91	0.41	14	0.79
1996	44	0.80	35	132	2.99	0.37	49	1.11
1997	81	0.83	67	291	3.59	0.15	44	0.54
1998	53	0.80	42	250	4.72	0.19	48	0.91
1999	59	0.39	23					
2000	152	0.37	56					
2001	444	0.70	311					
2002	246	0.66	162					
2003	238	0.76	181					

Table 6. Geomean abundance and productivity estimates. Current abundance and productivity values are boxed.

	R/S measures				Lambda measures		Abundance
	Not adjusted		SAR adjusted		Not adjusted		Nat. origin
	median	75% threshold	median	75% threshold	1987-1998	1979-1998	geomean
delimited							
Point Est.	1.09	0.72	1.00	0.72	1.03	0.99	63
Std. Err.	0.34	0.22	0.13	0.15	0.33	0.19	0.31
count	10	20	10	20	12	20	10

Table 7. Poptools stock-recruitment curve fit parameter estimates. Values determined to be out of bounds are highlighted.

SR Model	Not adjusted for SAR							Adjusted for SAR						
	a	SE	b	SE	adj. var	auto	AICc	a	SE	b	SE	adj. var	auto	AICc
Rand-Walk	0.72	0.15	n/a	n/a	0.55	0.63	59.9	0.72	0.11	n/a	n/a	0.40	-0.29	44.9
Const. Rec	114	22	n/a	n/a	n/a	n/a	54.6	114	21	n/a	n/a	n/a	n/a	54.2
Bev-Holt	3.59	3.29	155	51	0.40	0.61	55.3	1.32	0.46	296	129	0.33	-0.18	43.0
Hock-Stk	0.72	0.15	9666	0	0.55	0.63	62.7	1.09	0.22	142	36	0.31	-0.09	40.9
Ricker	1.71	0.66	0.00423	0.00164	0.43	0.61	56.9	1.27	0.34	0.00278	0.00114	0.33	-0.16	42.5

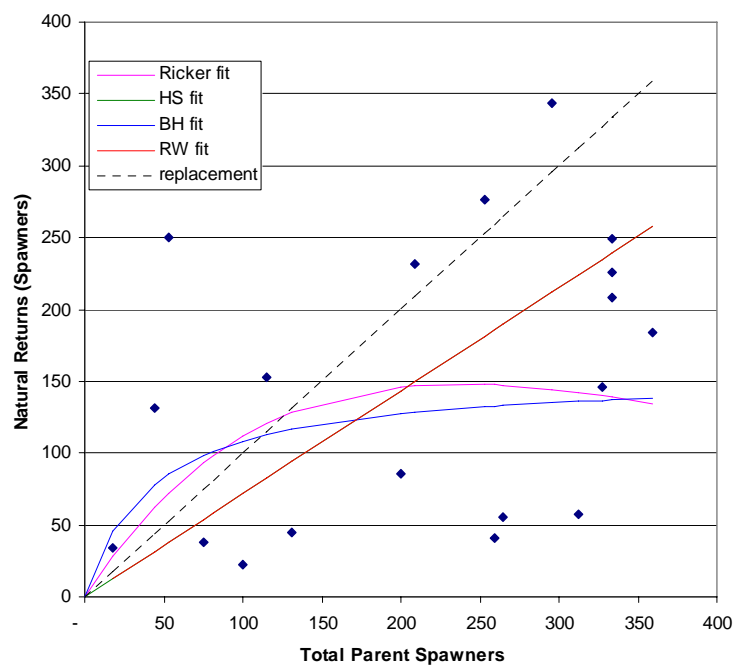


Figure 8. Entiat Spring Chinook stock-recruitment curves for the most recent 20-year data series. No adjustment was made for marine survival.

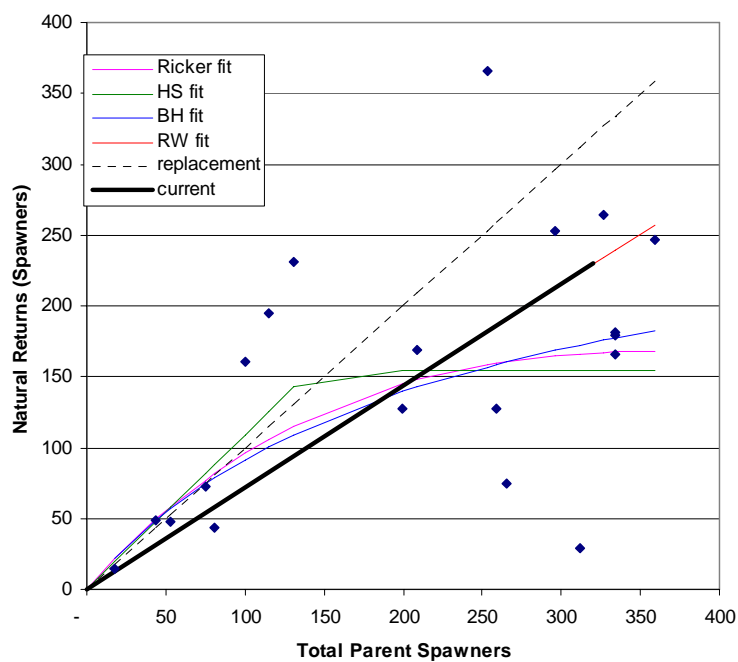


Figure 9. Entiat Spring Chinook stock-recruitment curves for the most recent 20-year data series. An adjustment was made for marine survival.